Chemical SAFETY AND SECURITY TRAINING

Workshop

Cairo, Egypt

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Sandia National Laboratories

Emergency Planning and Response

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Environmental & Chemical Safety Educational Institute

Emergency planning and response is based on safety principles of

- Anticipation
- Recognition
- Evaluation
- Control

Emergency Planning & Response

Have an evacuation plan

and

POST IT

Emergency Planning & Response

Don't use hallways for storage

Dangerous!!

Blocks passage and emergency exit path

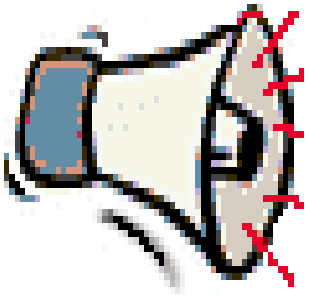
Emergency Planning & Response

- Have routine, unannounced evacuation drills
- Test and maintain alarms
- Designate person for each area to ensure bathrooms, etc. are evacuated

- Locate outside staging areas sufficient distance from building
- Designate person to meet/direct emergency vehicles

Emergency Planning & Response

Alarm systems need to be properly located, maintained, and serviced regularly



CSP CHEMICAL SECURITY ENGAGEMENT PROGRAM

Chemical SAFETY AND SECURITY TRAINING

Emergency Planning & Response

Centrally locate and maintain fire extinguishers and alarms

Emergency Planning & Response

If people are expected to use extinguishers

they must be trained

Emergency Planning & Response

Post each room with:

- Emergency phone numbers
- After hour phone numbers
- Person(s) to be contacted
- Alternate person(s)
- Unique procedures to be followed

Location	
Hazards Within:	
Primary Contact:	
Second Contact:	
Building Monitor/Safety:	
Department Head:	
Fire/Police/Ambulance:	911
Envir. Health & Safety (or RSO, if needed):	646-3327

Emergency Planning & Response

Label and keep all exits clear, unlocked or equipped with panic bars

Chemical Exposures to Eyes or Skin

Centrally locate safety showers and eyewashes

- Remove contaminated clothing
- Thoroughly flush with water
- Follow chemical specific procedures (i.e.. HF)
- Seek medical assistance

Chemical Spills

Centrally locate spill clean-up kits

Clean up spill only if you know the chemical hazards, have appropriate equipment and are trained to do so!

- alert colleagues and secure area
- assess ability to clean-up spill
- find spill kit
- use appropriate PPE and sorbent material
- protect sinks and floor drains
- clean-up spill, collect/label waste for disposal
- report all spills

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Chemical SAFETY AND SECURITY TRAINING

Chemical Management Best Practices

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Environmental & Chemical Safety Educational Institute

Chemical Management

Best Practices

References

"Less is Better," American Chemical Society, Washington DC, 2003, available online: http://membership.acs.org/c/ccs/publications.htm

"School Chemistry Laboratory Safety Guide," US NIOSH Publication 2007-107, Cincinnati, OH, 2006, available on-line: http://www.cpsc.gov/CPSCPUB/PUBS/NIOSH2007107.pdf

"Prudent Practices in the Laboratory: Handling and Disposal of Chemicals," National Academy Press, 1995, available online: http://www.nap.edu/catalog.php?record_id=4911

Chemical Management

Institute a Safety Program

- Have a Safety Manual
- Appoint a chemical safety officer for each major area/section/group/building
- Form a Safety Committee
- Have periodic safety training (films, etc)
- Have safety inspections
- Investigate serious accidents/incidents
- Follow-up!

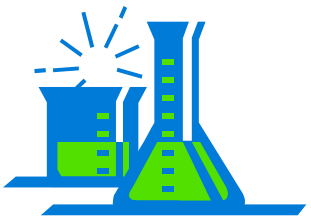
Cradle - to - grave care of chemicals

Receipt → **Storage** →

Use → **Disposal**

Plan experiments in advance!

What chemicals are needed?



How much is needed?

How will the chemicals be handled?

What are the reaction products?

How will the chemical be stored?

How will disposal take place?

Inventory management

Less is Better !

- Order only what you need
- Reduce size of experiment
- It costs less to store
- It costs less to dispose

"Less is Better: Guide to minimizing waste in laboratories", Task Force on Laboratory Environment, Health and Safety, American Chemical Society, 2002. http://membership.acs.org/C/CCS/pub_9.htm

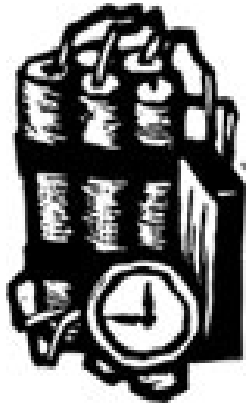
Inventory management

Less is Better !

It's Safer!

It may be cheaper to order diethyl ether in large containers

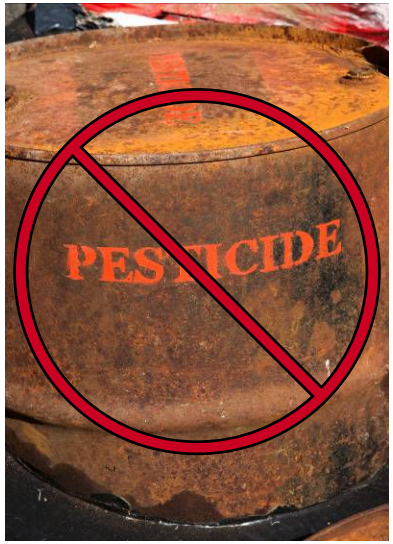
But, if it's opened for a long time—peroxides can form!



Inventory management

- How old are your chemicals?

- Some chemicals degrade over time
  - rotate stock
  - label & date



Inventory management

-R-O-O-R-

Peroxide Forming Chemicals

Even with inhibitors they can become dangerous over time

- **discard or test if unsure**
- **label & date**

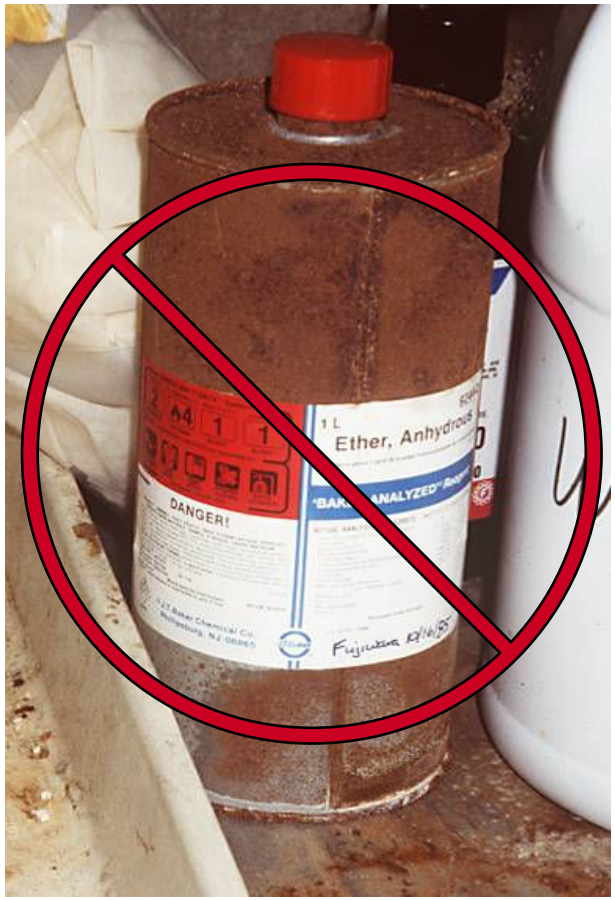
when received,
when opened, and
provide expiration date

Peroxide forming chemicals

- Peroxide formation is caused by an autoxidation reaction.
- The reaction is initiated by light, heat, introduction of a contaminant or the loss of an inhibitor (BHT).
- Inhibitors slow, but do not stop peroxide formation.
- Most organic peroxide crystals are sensitive to heat, shock, or friction.
- It is important not to let peroxide forming chemicals evaporate to dryness or accumulate under screw caps.

-R-O-O-R-

Peroxide forming chemicals



Peroxides can explode when exposed to thermal or mechanical shock

Examples: ethers, dioxane, tetrahydrofuran

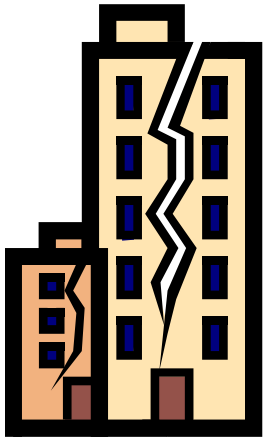
References:

There are excellent websites on peroxide forming chemicals and their hazards, use, storage, and disposal. For example, see:

http://www.med.cornell.edu/ehs/updates/peroxide_formers.htm

Chemical storage

- **Protect chemicals during normal operations**
- **Protect chemicals during unexpected events**
  - **Floods**
  - **Tidal waves**
  - **Earthquakes**
  - **Typhoons**
  - **Hurricanes**



Chemical storage: Basic concepts

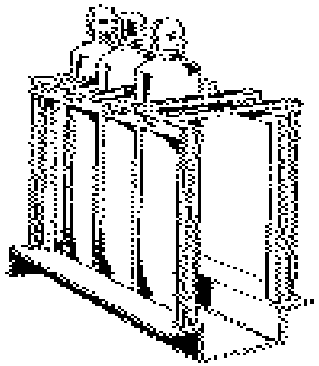
- Separate incompatible chemicals
- Separate flammables/explosives from ignition sources
- Use flammable storage cabinets for large quantities of flammable solvents
- Separate alkali metals from water
- Separate acids and bases

Use flammables storage cabinets

Chemical storage: Basic concepts

- Store nitric acid separately
- Store large containers on bottom shelves
- Lock up drugs, chemical surety agents, highly toxic chemicals
- Do not store food in refrigerators with chemicals

Chemical storage: Gas cylinders



- Secure (chain/clamp) and separate gas cylinders
- Screw down cylinder caps
- Store in well-ventilated area
- Separate & label empty cylinders
- Store empty cylinders separately
- Separate flammable from reactive/oxidizing gases

Improper gas cylinder storage

Gas Cylinders

Exploded nitrogen cylinder

Chemical storage: Cryogenics

- Store gases & cryogenics separately from other chemicals
- Store cryogenics (liquid nitrogen) & dry ice in well ventilated areas
- Use proper PPE (including eye protection) when handling & moving cryogenics
- Do not use cryogenics in closed areas

Chemical storage: Good practices

- **Limit access**
  - **Label "Authorized Personnel Only"**
  - **Lock area/room/cabinets when not in use**
- **Be sure area is cool and well ventilated**
- **Secure storage shelves to wall or floor**
- **Shelves should have a ¾" front lip**
  - **In earthquake territory, have a rod several inches above shelf**

- **Separate incompatible chemicals**
  - **Organize chemicals by compatible groups**
  - **Alphabetize chemicals only within compatible groups**

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Chemical storage: Bad practices

- **Do Not Store Chemicals**
  - **on top of cabinets**
  - **on floor**
  - **in hoods**
  - **with food or drinks**
  - **in refrigerators used for food**
  - **where there are wide variations in temperature, humidity or sunlight**

Chemical storage: Containers

- Don't use chemical containers for food
- Don't use food containers for chemicals
- Be sure all containers are properly closed
- Wipe-off outside of container before returning to storage area
- Transport/carry all containers safely
  - Preferably use outer protective container

Improper chemical storage

Never use hallways for storage

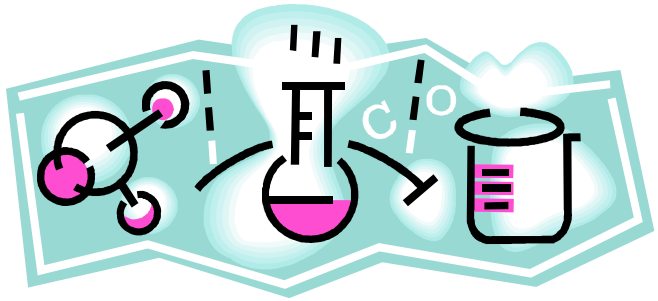
Safety Hazard!!

Blocks exit path in emergencies!!!

Suggested shelf storage groups: Organics

- Acids, anhydrides
- Alcohols, amides, amines
- Aldehydes, esters, hydrocarbons
- Ethers, ketones, halogenated hydrocarbons
- Epoxies, isocyanates
- Azides, peroxides
- Nitriles, sulfides, sulfoxides
- Cresols, phenols

From: "School Chemistry Laboratory Safety Guide," US NIOSH Publication 2007-107



Suggested shelf storage groups: Inorganics

- Metals, hydrides
- Halides, halogens, phosphates, sulfates, sulfides
- Amides, azides, nitrates, nitrites
- Carbonates, hydroxides, oxides, silicates
- Chlorates, chlorites, perchlorates, peroxides
- Arsenates, cyanides, cyanates
- Borates, chromates, manganates
- Acids
- Arsenics, phosphorus, sulfur

From: "School Chemistry Laboratory Safety Guide," US NIOSH Publication 2007-107

Waste management: General guidelines

- Secure and lock waste storage area
- Post signs to warn others
- Keep area well ventilated
- Provide fire extinguishers and alarms, spill kits
- Provide suitable PPE
- Provide eye wash, safety showers
- Do not work alone

Waste management: General guidelines

- Insure against leakage; dyke area if possible
- Label all chemicals, containers, vials
- Separate incompatible chemicals
- Keep gas cylinders separate
- Keep radioactive material separate
- Know how long waste can be stored
- Provide for timely pick-up

Dangerous waste management

Waste management

- Recycle, reuse, redistill if possible
- Dispose by incineration, if possible
- Incineration is NOT the same as open burning

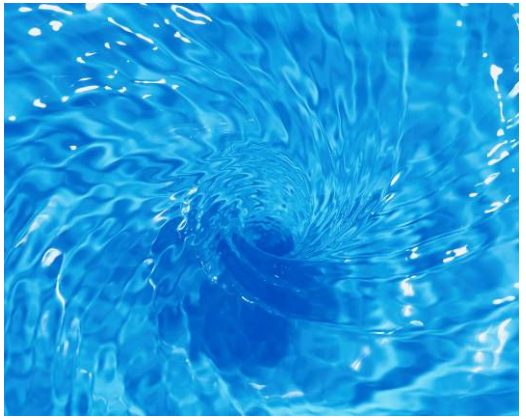
Waste management: Waste disposal service

- Is disposal service licensed?
- How will waste be transported?
- How will waste be packaged?
- Where will material be disposed?
- How will it be disposed?
- Maintain written records

Waste management: Down the drain?

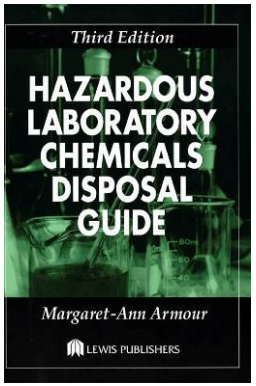
If legally allowed:

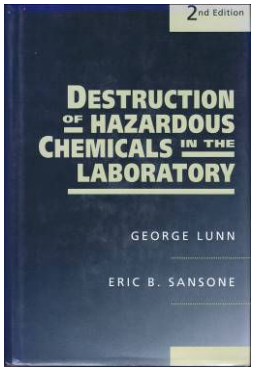
- **Deactivate & neutralize some liquid wastes yourself**
  - **e.g., acids & bases**
  - **Don't corrode drain pipes**
- **Dilute with lots of water while pouring down the drain**
- **Be sure that you do not form more hazardous substances**



Waste management: Treatment in Lab?

- Destruction / neutralization of hazardous chemicals
  - May or may not be allowed by regulations
  - Must be done by trained chemist
  - Specific to each chemical
- References:
  - "Procedures for the Laboratory-Scale Treatment of Surplus and Waste Chemicals, Section 7.D in Prudent Practices in the Laboratory: Handling and Disposal of Chemicals," National Academy Press, 1995, available online: http://www.nap.edu/catalog.php?record_id=4911
  - "Destruction of Hazardous Chemicals in the Laboratory, 2nd Edition", George Lunn and Eric. B. Sansone, Wiley Interscience, 1994, ISBN 978-0471573999.
  - "Hazardous Laboratory Chemicals Disposal Guide, Third Edition", Margaret-Ann Armour, CRC Press, ISBN 978-1566705677





Chemical management

- Proper chemical management is an important part of laboratory safety and security
- Helps protect people, laboratories and the environment
- Can save money by avoiding duplicate chemical purchases